



NASA STTR 2009 Phase I Solicitation

T10 Rocket Propulsion Testing Systems

NASA's Stennis Space Center (SSC) seeks advanced vacuum technologies to support its new test stand for testing rocket engines in a vacuum. Also needed are technologies for reclamation of the large amounts of helium and hydrogen gases used during engine testing.

Subtopics

T10.01 Test Area Technologies

Lead Center: SSC

Vacuum System Technologies

John C Stennis Space Center is embarking on a very ambitious era in its rocket engine propulsion test history. The construction of the new A3 test stand is in progress which is designed to test a very large (294,000 lbf thrust) cryogenic rocket engine at a simulated altitude of 100,000 feet. When the air in the engine test chamber is evacuated, the simulated altitude pressures inside the test chamber will be less than 0.20 PSIA. This will result in a very unique environment with extremely low pressures inside a very large chamber and ambient pressures outside this chamber. Due to the unique nature of this test facility, new technologies and measurement techniques will need to be developed which includes but is not limited to:

- Instrument closeouts at vacuum pressures for hundreds of channels of instrumentation entering the chamber;
- New sealing technologies for large cryogenic piping entering this very large test cell wall to seal against this unique environment;
- Methods of generating vacuum for test, measurement and calibration of test stand systems and instrumentation;
- Fatigue life prediction techniques for the thousands of square feet of sheet metal used in the construction of the test chamber and diffuser ducting which will be cycling between ambient and vacuum pressures;

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- Inspection techniques for the vacuum chamber structures and diffuser ducting.

GHe Reclamation

Due to the size of the cryogenic rocket engines and the test facilities required to test the engines, extremely large quantities of helium are used during testing each year. This requirement makes Stennis one of the world's largest users of gaseous helium which is a non-renewable natural resource. Cost of helium is increasing as the supply diminishes. The cost and shortage of helium are beginning to impact testing of the rocket engines for the space propulsion systems.

Innovative solutions are needed for efficient, cost effective, in-situ methods to recapture helium used during the engine purging and testing processes, to reclean the captured helium, to repressurize it, and then to reintroduce it for reuse. Research into technologies in these areas, demonstration of the technology capability, and conceptual design for the technology installation at Stennis are desired to assist in the helium reuse.

Helium used in rocket engine purge must meet very specific cleanliness standards. One of the challenges will be to develop and in-situ, on-site helium re-utilization system capable of recycling the helium to the cleanliness standards requirements.

The technologies developed to recapture and clean the helium must be cost effective and able to perform the recycling process in an in-situ rocket engine test area environment. It will be required to comply with all safety and quality standards required in this environment.

Hydrogen Reclamation

Due the testing of cryogenic rocket engines, SSC is one of the world's largest users of hydrogen. Currently, the LH2 is brought to SSC by trucks. During transfers and test operations, there huge amounts of LH2 lost due to boiloff as the heat in the systems causes the LH2 to phase into gaseous hydrogen. Conservatively, approximately one half of the hydrogen bought for use in test programs is lost or wasted during these operations.

The vast majority of this hydrogen boiloff is burned in the facility flare stacks as a safety precaution. The capability to reclaim and reutilize this hydrogen boiloff could offer potential savings of millions of dollars annually. The emerging hydrogen economy has developed systems and technologies that could potentially make use of this wasted hydrogen if methods were developed to recover at least a portion of the boiloff for reuse. A potential utilization would need to capture, reclean, repressurize and store this boiloff for reuse by the test facility. Options for the reuse of this reclaimed hydrogen could be as GH2 in the test facility or potentially even other alternate energy uses. Another possible option would be to reliquify and reuse the boiloff as propellant if this were economically efficient.

Innovative solutions are needed for efficient, cost effective, in-situ methods to recapture the hydrogen boiloff, to reclean and repressurize it, and then to store it for reuse. Research into technologies in these areas, demonstration of the technology capability, and conceptual design for the technology installation at Stennis are desired to assist in the hydrogen recovery and reuse.

The primary challenge will be to safely capture, process and store the large amounts of gaseous hydrogen released during test operations. Gaseous hydrogen used in rocket engine test operations must meet very specific cleanliness standards. Another challenge will be to develop an in-situ, on-site system capable of recycling the captured hydrogen to the cleanliness standards requirements. An additional challenge will be to determine the appropriate utilization of the recaptured hydrogen for test operations or alternative energy uses.

The technologies developed to capture and clean the hydrogen must be cost effective and able to perform the recycling process in an in-situ rocket engine test area environment. It will be required to comply with all safety and quality standards required in this environment.

T10.02 Energy Conservation and Sustainability

Lead Center: SSC

John C Stennis Space Center (SSC) is a large rocket propulsion test facility located in southern Mississippi close to the Louisiana state line. Due to the size of the test facilities, energy consumption is very large. In an effort to conserve on energy, there is an interest in pursuing innovation in the following areas:

Innovative Geothermal Technology

SSC is interested in innovative geothermal technology in an effort to reduce energy consumption, reducing the Center's carbon footprint. The feasibility and application of geothermal technology has not been investigated for use at SSC. SSC is looking for geothermal technology that is cost effective to implement and maintain. There are potential commercial and residential applications. The feasibility of geothermal technology will require an assessment of the local topography, underground soil composition, location of water "sinks", and determination of the area's ground "constant" temperature. Concepts will be evaluated based on their potential efficiency, ease of implementation and maintenance, and flexibility of applications (including, but not limited to, HVAC, preheating hot water heaters, and other means of extracting energy). Proposals will also be evaluated based on the maturity level to which the technology will be developed and innovative techniques.

Innovative Lighting Technology

Stennis Space Center is interested in developing innovative technologies, systems, or methodologies that will reduce the energy consumption and heat generation from facility lighting while maintaining the desired level of illumination for safety and effective work environments. SSC is interested in innovative lighting technologies for the test area and parking lots. These lighting technologies will need to reduce energy consumption while maintaining a comfortable and safe working environment. SSC is particularly interested in replacing costly lighting in the test area (test stands, hydrogen/oxygen environments, hazardous and potentially corrosive environments). The lighting should be in compliance with IESNA RP 7-01, Practice for Industrial Lighting. Proposals will be evaluated based on the maturity level to which the technology will be developed and innovative techniques that will provide a reasonable life expectancy. Proposals will also be evaluated on implementation strategy and ease of maintenance.

Assessment of Best Practices to Determine Test Programs Carbon Footprint and Environmental Impact

SSC is interested in technologies, systems, or methodologies for measuring and analyzing the carbon footprints of rocket engine testing activities. Due to the variety of rocket engine propulsion systems testing and the nature of the facilities required for testing, it would be useful to have ways to measure and understanding the carbon footprint generated by these test activities to effectively control and mitigate them as much as possible. A relatively generic methodology that can be suited for different test programs is desirable. Proposals will be evaluated based on the feasibility and applicability of Life Cycle Assessment on test programs or other applicable carbon assessment tools. Tools developed should be in compliance with ISO 14044 and ISO 14040.